THE EFFECT OF CARCINOGENIC AGENTS ON THE PHOSPHORUS CONTENT OF HAIR BULBS AND EPIDERMIS

The Effect of X-Rays on the Phosphorus Content of the Hair Bulbs*

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In a previous paper it has been demonstrated that a positive calcium phosphate reaction can be observed in the skin on the border surface between the epidermis and cutis as well as on the surface of the hair bulbs and the follicles. It was also shown that on the surface of hair bulbs removed by the action of X-rays and thallium, the calcium phosphate reaction fails to occur. On investigating the cause of this occurrence, it was found that because of the disappearance of the inorganic phosphate, the reaction becomes negative on the surface of the hair bulbs epilated by X-rays or by thallium.

In view of the important role attributed to the phosphorus metabolism in the energy-producing processes within the cell (2, 3) as well as of that of the changes effected by X-rays on malignant growths, our present investigations attempt to establish whether or not alterations can be recorded in the total phosphrous content of the hair bulbs pursuant to their epilation by X-rays. From the point of view of the investigation of the effect exerted by local X-ray irradiation, the examination of the changes occurring in the hair bulbs seemed particularly suitable as the latter are very sensitive to X-ray irradiation. These changes are far more pronounced in them than in tissues less sensitive to irradiation. This is also supported by the results of a previous paper in which it was shown that in the roots of human hairs epilated with X-rays (450 r) the catalase activity ceases completely, and that following contact X-ray irradiation with 1000 or 2000 r, the catalase activity in the epithelium of rats and mice falls to about one half.

METHODS

The epilated hairs were obtained from eight male patients to whom X-ray treatment (450 r) had been administered because of pyogenic process of the scalp. The hairs which fell out were placed on a white glass plate and their bulbs cut off with a small knife. The bulbs of the epilated hair can be recognized with the naked eye because of their being slightly sharpened at the ends and having a darker color. The controls were obtained from healthy individuals. The bulbs were cut off with a knife in a similar way, care being taken that a keratinized hair portion or a follicle was not mixed into the material to be examined. (Among the plucked healthy hair roots there are many which are surrounded in a sheath-like manner by the follicle, whereas in epilated hair roots this does not occur.)

For every investigation, 400–2500 hair bulbs epilated with X-rays were used. The control group contained 100–300 hair bulbs. The examined material was

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TABLE 1

Hair Bulbs Fallen Out on the Action of X Rays				Healthy Hair Bulbs		
Number	N γ	P γ	P γ/100 γ N	N γ	P γ	P γ/100 γ N
1	32	0	—	29	5.0	17.2
2	85	0	—	90	12.7	14.1
3	125	0	—	55	6.8	12.3
4	265	0.7	0.22	60	8.2	13.6
5	110	0	—	45	5.6	12.4
6	125	0	—	48	7.5	15.6
7	112	0	—	52	7.3	14.0
8	42	0	—			
9	50	0	—			
10	46	0	—			
11	38	0	—			

incinerated in tubes the bottom of which had a conelike shape on the water bath with 0.16 ml concentrated sulphuric acid and 1–2 drops of hyperol. After the incineration, the volume was made up with distilled water to 2.5 ml in 0.5 ml of which the nitrogen content was examined. The phosphorus content was examined in 2.0 ml. The nitrogen content was determined with Nessler's reagent photometrically. The phosphorus content was also estimated photometrically; essentially the procedure is based on the method of Fiske-Subbarov as it has been modified by Langemann (5). The results were recorded by means of the Pulfrich photometer.

RESULTS

The results are illustrated on Table 1. For observations 1–4 concerning hair bulbs epilated by X-rays the hair bulbs were obtained from a single individual, whereas those of 5–11 originate from seven different individuals. It can be seen that while the healthy hair bulbs contain 12–17 microgram phosphorus per 100 microgram nitrogen, in the epilated hair bulbs containing 125 microgram nitrogen (this corresponds approximately to 1000–1200 hair roots), phosphorus could not be detected. In one single case only could a quite slight amount of phosphorus be observed when the number of the hair bulbs to be examined was increased to 2500. In this investigation the proportion was 0.7 microgram phosphorus to 265 microgram nitrogen. This is a negligibly small amount of phosphorus as compared with that found in healthy hair bulbs.

CONCLUSION

Our results indicate that hair bulbs epilated by X-rays lose most of the phosphorus they contained. This probably means that the phosphorus compounds of the hair bulbs were also completely destroyed. Considering the many various phosphorus compounds contained in the cells (acid-soluble phosphorus compounds, nucleic acids, phospholipids and phosphoproteins) and the significance

of the phosphorus metabolism in the intracellular energy-production, this change is of large magnitude and may offer an explanation for the perishing of the hair bulbs.

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